White blood cell segmentation by using vector color approach

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Article Info	Abstract
	White blood cells play an important role in protecting the body from various types of diseases, therefore blood tests are done to determine a person's disease. Diagnosis of blood diseases is done by analyzing and counting the white blood cells in the blood. Optimal calculations and analysis of white blood cell are important, so research on white blood cell detection is a rapidly growing topic. Many detection methods are proposed using the existing segmentation techniques. In this paper, the detection method is proposed using vector operation approach instead general segmentation technique. From the experiments performed, it is shown that the proposed method can detect white blood cells on smear images. Further, this method extracts the nucleus from white blood cells well.

INTRODUCTION

In general, blood has important functions for human health, such as supplying essential substances throughout the body and maintaining the immune system. The blood itself is made up of several major components, namely plasma, red blood cells, white blood cells, and platelets. White blood cells serve to protect the body from various infectious diseases caused by fungi, viruses, and bacteria. The number and shape of white blood cells is one of the indicators in detecting various types of diseases (Bain, 2017; Buxhofer-Ausch et al., 2021; Negm et al., 2018; Saleem et al., 2022). To find out the type of disease, it is necessary to perform a blood test, which aims to detect, count, and identify white blood cells, and the process is done manually and requires a lot of time. To reduce the diagnostic process time and the possibility of human error, a system and method for detecting and analyzing blood cells from smear images have been developed so far (Anilkumar et al., 2020; Nazlibilek et al., 2014; Shahin et al., 2019).

As we know, color pictures are formed from three different channels, namely red, green, and blue channels. Each channel is represented as a pixel value from 0 to 255. Blood smear images consist of plasma, red blood cells, and white blood cells. Image segmentation is a commonly used technique to develop methods for detecting white blood cells. Image segmentation aims to separate an image into several different images. The separation is done by utilizing features in the processed image, so that several images with similar features are obtained in each image. Segmentation is the part of

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image processing that aims to group the characteristics of an image so as to facilitate the process of analyzing the important parts or information contained in the image (Thomas & Sreejith, 2018).

In medical imaging, especially blood smear images, segmentation techniques are commonly used to develop blood detection algorithms. There are various types of segmentation techniques commonly used by researchers such as thresholding, edge-based, region-based, watershed, clustering-based, and neural network. Some recent research, builds the detection methods from a combination of known segmentation techniques rather than proposing detection techniques with new approaches (Abdurrazzaq et al., 2021; Liang et al., 2018; Settouti et al., 2020; Yao et al., 2021; Z. et al., 2017). This paper aims to propose a detection technique with a threshold concept and vector operation approach by utilizing color intensity of the pixel values in blood smear images.

METHOD

In some studies, the process of white blood cell detection is generally performed on grayscale smear images. The proposed method works on colored smear images, so that smear images do not need to be converted to grayscale. The proposed method uses a combination of RGB channels to obtain features on smear images that are then used to detect white blood cells.

As emphasized earlier, the proposed method uses RGB smear images, i.e. three RGB channel matrices with appropriate entries. Assume A as a smear image.

$$A = (R, G, B) \qquad (1)$$

From the three matrices, a vector will be formed containing the features in the processed smear image. The level of difference in pixel value for each part of the smear images will be calculated.

$$x = \left\| \begin{bmatrix} R_{ij} \\ G_{ij} \\ B_{ij} \end{bmatrix} \right\| \qquad (2)$$

Vector X will change dynamically following the smear image being processed not because of the number of stored databases. Furthermore, X is used to form boundaries to aid the white blood cell detection process.

$$B = \frac{(\min(x) + \max(x))}{2} \qquad (3)$$

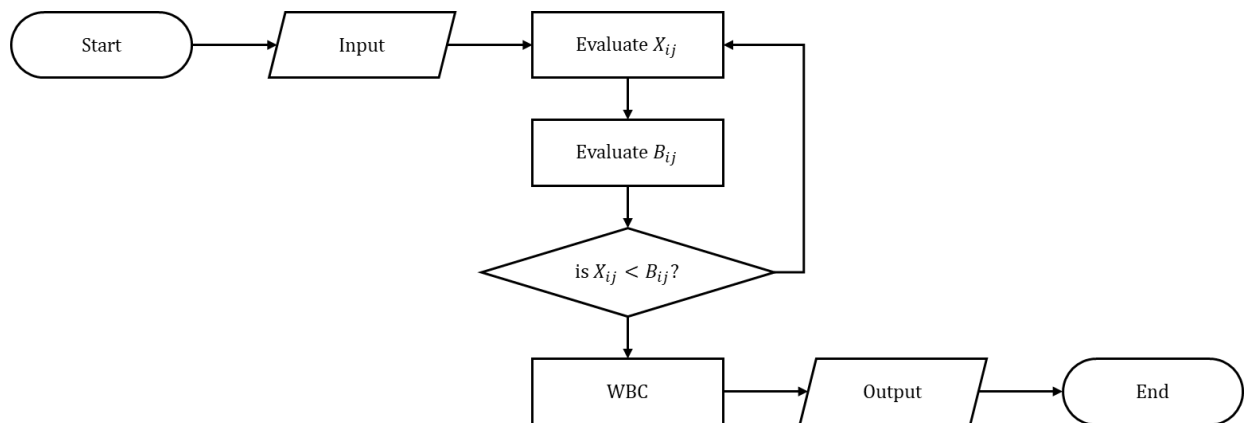Here is the flowchart of the proposed method (Figure 1).

Figure 1. Flowchart of the proposed method.

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RESULTS AND DISCUSSION

In this paper, a new method is proposed and used to detect white blood cells on blood smear images. To date, there are various methods for detecting blood cells that have been proposed and used. Most of these methods are constructed from modifications of concepts commonly used in image processing or incorporating existing concepts or methods. This aims to increase the effectiveness of the method so as to produce good output. The proposed method differs from the existing methods, because the proposed algorithm uses an algebraic concept approach, i.e. vector.
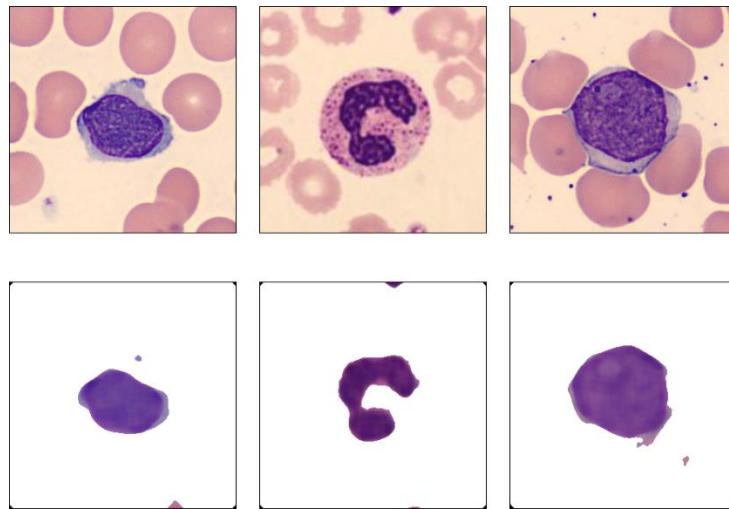
Figure 2. Visual results of simulation on the proposed method.

Blood smear images from (Xin, 2018) database were used to simulate the proposed method. The simulation results of blood smear images using the proposed method are shown in Figure 2, Figure 3, and Figure 4. Based on the simulation results that have been done, it shows that the proposed method can detect white blood cells from various types of databases with different color intensities.
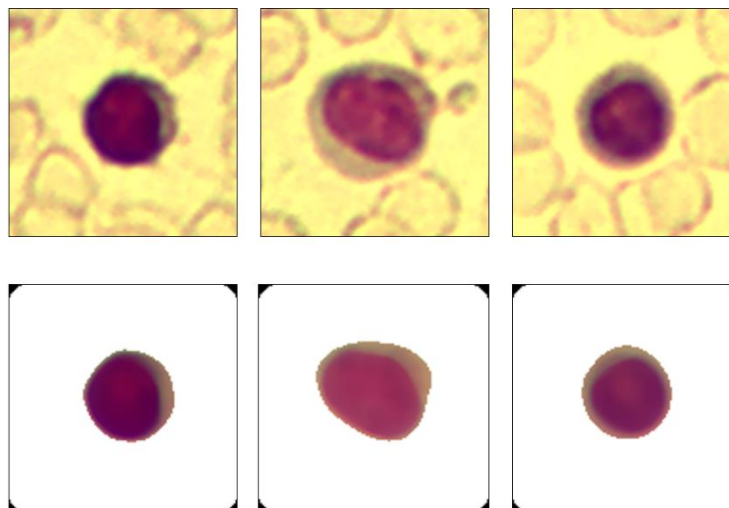
Figure 3. Visual results of simulation on the proposed method.

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This method works by considering every pixel in the smear images as a comparison and limit builder in decision making, so that the decision-making process will adapt, dynamically, to the processed blood smear image. Therefore, the constructed algorithm depends on the color intensity present in the smear images because each pixel on the smear images becomes an important indicator for features selection and decision making.
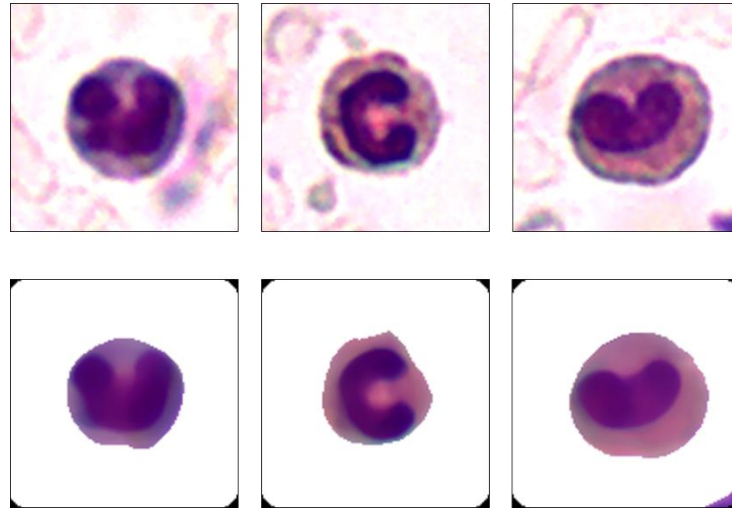

Figure 4. Visual results of simulation on the proposed method.

CONCLUSION

In this paper, we present a new method for detecting white blood cells. The constructed algorithm works on the color smear image by considering the distance of values between pixels in each part of the smear image. Further, based on the information collected, limit values were obtained in decision making for the white blood cell section. The simulation results show that the proposed method works very well in detecting white blood cells from several blood smear images. In addition, because the algorithm built on this method depends on the distance between the pixel values in the smear image, this method dynamically adjusts the detection process to the processed smear image. For further research, the method needs to be developed so that it can detect all parts of the white blood cell, not just the nucleus, so that the method can be implemented to detect disease based on the form of damaged white blood cell.

AUTHOR CONTRIBUTIONS

Each author of this article played an important role in the process of method conceptualization, simulation, and article writing

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